PATENT ABSTRACTS OF JAPAN

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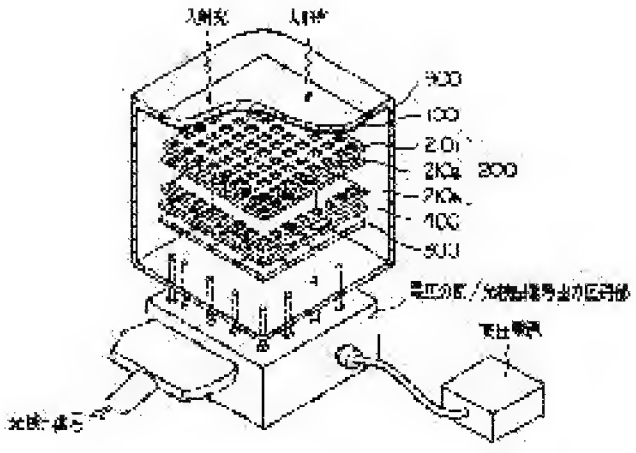
(54) POSITION DETECTING TYPE PHOTOMULTIPILER TUBE

(57)Abstract:

PURPOSE: To obtain a position detecting type photomultiplier tube, which can reduce the unevenness of the photo detecting signal, which is output in response to the incidence position of the light, generated in response to a place of an electron multiplier and which has the excellent positional resolution.

CONSTITUTION: Each dynode forming an electronic multiplier 200 for multiplying electron is formed common to the incidence position of a photoelectric surface 100, and a pixel signal output unit 300, which is arranged in a former stage of the acceleration of a collector electrode 400 in an acceleration route in response to the light incidence position and which has the secondary electron emitting function and which is formed of plural pixel electrodes, to which electric potential can be separately applied, is provided. Applied potential per each pixel electrode is adjusted to nearly even the unevenness of the photo detecting signal, which is output in



JAPANESE [JP,07-211280,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

* NOTICES *

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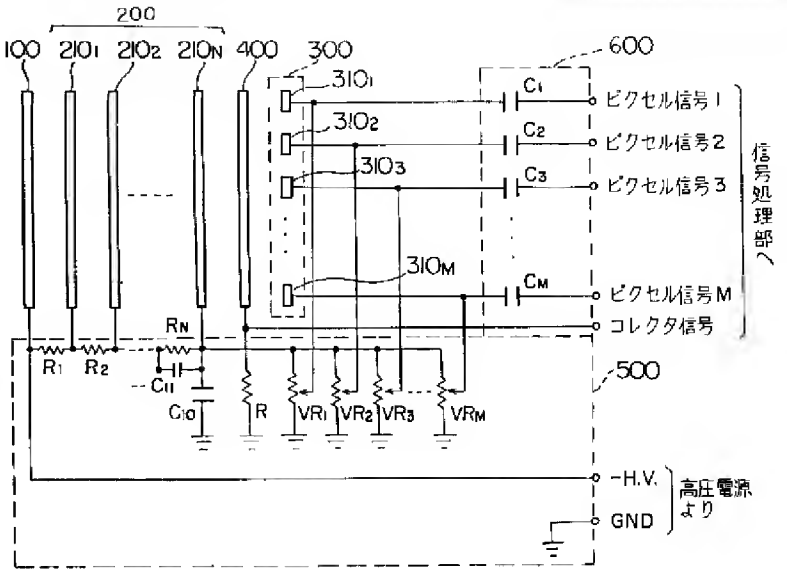
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the detecting position type photo-multiplier which detects the incidence intensity of light including an incidence position.
[0002]
[Description of the Prior Art]The photo-multiplier is widely used considering feeble light as high sensitivity and a photodetector detected at high speed. The detecting position type photo-multiplier which improved the resolution of the light incidence position is known employing the advantage of such a photo-multiplier efficiently. The following two types exist seeing such a conventional detecting position type photo-multiplier from structure.
[0003](1) The stage and a course independent dynode arrangement type (the 1st type)
This type of detecting position type photo-multiplier arranges in parallel two or more multi stage dynode structures where acceleration and multiplication course of the conventional photoelectron are acceleration and multiplication mechanism of one photo-multiplier, according to the light incidence position of a photoelectric surface. Since this type of detecting position type photo-multiplier can set up potential independently of each dynode, dynode impression potential is adjusted for every course, and it can use it, abbreviated-coinciding the electronic multiplication factor of each course. Drawing 5 shows the example of circuitry which enabled adjustment of the electronic multiplication factor, i.e., the wave height of a photodetection signal, for every course in the photo-multiplier (photo-multiplier which contained the dynode group (Dy1-Dy10, and Dy1'-Dy10') of two courses) of this type. With the same composition as drawing 5, the example of the photo-multiplier which can attain equalization of an electronic multiplication factor is indicated by JP,5-36372,A.

Drawing selection Drawing 3



[Translation done.]

[0004](2) stage independence and course common dynode arrangement type (the 2nd type)
This type of detecting position type photo-multiplier, without allocating the dynode for acceleration and multiplication individually according to a light incidence position, Position resolution is improved by strengthening the directivity of discharge of a multiplication electron, although it is electrically inseparable, and constituting from two or more electrodes which have arranged the anode part of signal extraction according to a light incidence position. Drawing 6 is a figure showing the example of composition of the important section of the photo-multiplier of this type. According to the light incidence position of the photoelectric surface (K) which is a cathode, a photodetection signal is outputted with a GND level as an anode output (A_1 - A_N).

[0005]
[Problem(s) to be Solved by the Invention]Since the detecting position type photo-multiplier of the 1st conventional type needs to separate from other courses and to build the dynode structure of one course for every detection block of an incidence position as mentioned above, there is a problem that improvement in the resolution of an incidence position is difficult.
[0006]The detecting position type photo-multiplier of the 2nd conventional type, Since regulation of the dynode potential which determines a multiplication factor for every acceleration / amplification course was not completed, there was a problem that the luminous intensity which entered into the position of the photoclectric surface where the detecting signal outputted from each anode electrode not necessarily corresponds by the heterogeneity of the electronic amplification factor by the place of an amplifier could not be reflected correctly. As a result, when observing the track and incidence intensity of the charged particle which passes the scintillator on a photoelectric surface combining a scintillator, a track cannot be determined with sufficient accuracy. In this case, although the thing to which it is outputted from each anode electrode and for which the amplifier which an amplification factor can adjust is installed for every photodetection signal, and correspondence with an output signal and incident light intensity is aimed at can be considered, In order to constitute the electronic circuit which maintains the high speed and the low noise characteristic of a photo-multiplier, attention must be paid to selection of parts and there is a problem of the fall of reliability and the enlargement of a device accompanying the increase in part mark. Although the heterogeneity between each anode electrode is measured a priori and how to carry out data processing after collecting photodetection signals can be considered, in measuring the signal strength of the wide range, there is a problem that the high-speed processing by an arithmetic circuit for exclusive use is difficult.
[0007]The purpose of this invention is as follows.
Be made in order to cancel the above problems, and reduce the heterogeneity of the multiplication factor which the photodetection signal outputted according to the incidence position of light produces by the place of an electron multiplier.
Provide the detecting position type photo-multiplier excellent in position resolution.

[0008]
[Means for Solving the Problem]A detecting position type photo-multiplier of this invention is provided with the following.
A photoelectric surface which is a detecting position type photo-

multiplier which detects incidence intensity of light, and an incidence position of light, and emits electrons by incidence of (a) light.
(b) An electron multiplier which outputs ****** by which multiplication was carried out from a local position according to an incidence position of a photoelectric surface while two or more steps were allocated, and dynode which enters and carries out multiplication of the electron inputted into an electronic accelerating direction one step or an electron emitted from a photoelectric surface and carried out multiplication of the electron.
(c) While carrying out multiplication of the electron outputted from an electron multiplier which was allocated according to an incidence position of a photoelectric surface, consisted of two or more pixel electrodes which can impress voltage independently, and was inputted with each pixel electrode and emitting it, A collector electrode which inputs collectively an electron outputted from a pixel-signals outputting part which outputs a photodetection signal reflecting luminous intensity which entered into a field of a photoelectric surface according to each pixel electrode, and (d) pixel-signals outputting part, and outputs a signal according to a total of an input electron.

[0009]Here, dynode of each stage of an electron multiplier is good also considering what comprises a member of one electrically as a feature. What is been lamination type dynode is preferred for dynode of an electron multiplier.
[0010]While carrying out the substantial penetration of the electron which a collector electrode was allocated between dynode of a final stage of an electron multiplier, and a pixel-signals outputting part, and was outputted towards said pixel-signals outputting part from said electron multiplier, Each pixel electrode of said pixel-signals outputting part is good also considering what reflection type secondary electron emission is performed for as a feature. It is possible to use a wire form electrode arranged by a mesh form electrode, a grid form electrode, one dimension, or two dimensions for a collector electrode.
[0011]Potential impressed to each pixel electrode of a pixel-signals outputting part, When a signal outputted from a pixel electrode corresponding to incident light intensity in a field of said photoelectric surface according to each pixel electrode is the same incidence intensity, it is good also considering what is adjusted so that it may become uniform substantially between pixel electrodes as a feature.
[0012]
[Function]In the detecting position type photo-multiplier of this invention, if light enters into a photoelectric surface, a photoelectron will be emitted from an incidence position. Since kinetic energy is comparatively small when emitted from a photoelectric surface, this photoelectron advances to the direction and in parallel [abbreviated] of an electric field it has generated between a photoelectric surface and an electron multiplier (specifically first rank dynode), and is inputted into the electronic incidence area of the electron multiplier according to the incidence position of the photoelectric surface. In an electron multiplier, between each dynode, each dynode deters the spatial breadth of a secondary electron, and carries out electronic multiplication one by one while it emits a secondary electron with an incident electron and carries out electronic multiplication of the signal. And from the dynode of a final stage, the electrons which carried out multiplication with the multiplication factor as an electron multiplier are emitted from the local field according to the

incidence position of the photoelectric surface. In order to constitute such an electron multiplier, it is preferred to make each dynode into lamination type dynode.

[0013]It is accelerated and the electron outputted from the electron multiplier reaches one or more pixel electrodes arranged according to the incidence position of the photoelectric surface of a pixel-signals outputting part. These pixel electrodes are set up so that potential may abbreviated-equalize for example, to the luminous intensity which entered into the field of the photoelectric surface corresponding to each pixel electrode of the photoelectric surface in the waveforms (for example, wave height etc.) of the photodetection signal generated in the electronic incidence and the discharge of a secondary electron in each pixel electrode. The pixel electrode which entered the electron from an electron multiplier emits a secondary electron while outputting the photodetection signal according to the number of incident electrons for every pixel electrode. By observing this photodetection signal, the light incidence position in a photoelectric surface can be known. The photodetection signal outputted from each pixel electrode is reflecting the light intensity which entered into the position (field) of the photoelectric surface according to each pixel electrode also in a relative relation with each of other pixel electrode. After being accelerated, the electron emitted from each pixel electrode reaches a collector electrode collectively, and serves as a collector signal. Usually, (when the electronic multiplication factor in each pixel electrode is larger than 1 enough or the electronic multiplication factor in each pixel electrode is comparable), this collector signal is reflecting the full strength of the light which entered into the photoelectric surface.

[0014]by collecting the photodetection signals which each pixel electrode of the pixel-signals outputting part in the process from such light incidence to generating of a collector signal outputs, it is a high resolution about the incidence position of the light to a photoelectric surface, and the intensity of the incident light by an incidence position is passed through and reflected to a photodetection signal -- it can carry out.

[0015]

[Example]Hereafter, the example of this invention is described, referring to an accompanying drawing. In explanation of a drawing, the same numerals are given to the same element and the overlapping explanation is omitted to it.

[0016]Drawing 1 is an outline lineblock diagram of the detecting position type photo-multiplier which is an example of this invention. The photoelectric surface 100 as a cathode which the photo-multiplier of this example is formed in (a) plate-like, receives light, and generates a photoelectron like a graphic display, (b) The electron multiplier 200 which is provided with lamination type dynode 210_1 which emits the secondary electron arranged in multistage to an electronic accelerating direction - 210_N, carries out multiplication of the photoelectron and outputs it, (c) While consisting of a pixel electrode of plurality (drawing 1 16 pieces) arranged according to the light incidence position of a photoelectric surface, inputting the electron emitted from the electron multiplier 200 and emitting a secondary electron, While penetrating substantially the electron which was allocated between the pixel-signals outputting part 300 which outputs a photodetection signal from each pixel electrode, and the (d) electron multiplier 200 and the pixel-signals outputting part 300, and was emitted from 200 pixels of electron multipliers, It has the collector electrode 400 which collects collectively the electrons outputted from each pixel electrode of the signal output part 300, and

the container 900 which stores (e) and (a) - (d) and maintains an inside at an abbreviated vacuum.

[0017]Here, fine mesh type dynode was adopted as lamination type dynode 210_1 - 210_N. In addition to fine mesh type dynode, it is possible to adopt grid type dynode, mesh type dynode, Venetian blind type dynode, metal channel type dynode, or micro-channel-plate (MCP) type dynode.

[0018]Drawing 2 is an explanatory view of a constructional example employable as the collector electrode 400. Drawing 2 (a) shows the mesh structure of the quadrangular shape adopted by this example, and drawing 2 (b) shows hexagon-like net mold structure. Drawing 2 (c) shows the structure constituted from a wire type electrode arranged to two dimensions (X, Y). In drawing 2 (c), although the wire was arranged in the shape of two dimensions, one-dimensional arrangement is also possible. While penetrating substantially the electron which one opening of the collector electrode 400 did not need to be in agreement with the size of a pixel electrode, and was emitted from the electron multiplier 200, It is determined from the functional point of collecting efficiently collectively the electrons outputted from each pixel electrode of the signal output part 300.

[0019]Drawing 3, The output form of the signal outputted from each electrode 310_1 - 310_M, and the collector electrode of the photoelectric surface 100, the electron multiplier 200, the pixel-signals outputting part 300 and the voltage division part 500 that generates the potential impressed to a collector electrode, and the pixel-signals outputting part 300. It is a circuitry figure with the photodetection signal outputting part 600 to prepare.

[0020]** series connection the voltage division part 500 The voltage division circuit where variable resister VR_1 by which multiple connection was carried out to resistor R_1 carried out - R_N - VR_M were connected in series, The collector electrode 400 is made into a GND level, and it is ** constituted with C_{10}, C_{11}, etc. which are added if needed to waveform maintenance of the resistance R of which extraction of a collector current signal is made possible, and ** high speed signal. Like a graphic display, the high tension (- H. V.) of the negative polarity supplied from a high voltage power supply is impressed to one terminal of the resistor group of resistor R_1 by which the series connection was carried out - R_N. -H.V. is impressed also to the photoelectric surface 100. Each voltage which is produced for the terminal of resistor R_1 by which the series connection was carried out - R_N and by which the partial pressure was carried out is impressed to tie node 210_1 - 210_N, respectively. Each one fixed terminal of variable resister VR_1 - VR_M is connected to GND, and the fixed terminal of another side is connected to the terminal of resistor R_N. And voltage is individually supplied to each pixel electrode 310_1 of the pixel electrode outputting part 300 - 310_M from each variable terminal of variable resister VR_1 - VR_M.

[0021]The photodetection signal outputting part 600 insulates in direct current, and penetrates in exchange the photodetection signal (the pixel signals 1 - pixel-signals M) generated in each pixel electrode 310_1 - 310_M, It has capacitor C_1 which enables processing of next processing as a signal of a GND level - C_M. The photodetection signal (collector signal) outputted from the collector electrode 400 is outputted as it is.

[0022]this example **** photodetection is carried out as follows. In advance of actual photodetection, the photoelectric surface 100 is irradiated with the short pulse light of uniform intensity, and the wave height of each pixel signals is measured. If these wave heights have unevenness, variable resister VR_1 - VR_M will be operated and the output voltage from a variable terminal will be controlled. By control of the output voltage from this variable terminal, the impressed electromotive force of each pixel electrode is adjusted, and abbreviated equalization of the wave height of pixel signals is performed. Drawing 4 is a graph which shows the typical example of change of the output value of the photodetection signal outputted from the pixel electrode at the time of changing the potential of a pixel electrode from the potential of dynode 210_N to the potential (namely, GND level) of the collector electrode 400. Control of an output signal is possible to about [of a maximum output value] 1/10 so that clearly from drawing 4. Photodetection is performed after the above presetting.

[0023]If light enters into a photoelectric surface, a photoelectron will be emitted from a photoelectric surface. It is accelerated by the electric field generated between dynode 210_1 of the electron multiplier 200, and the photoelectric surface 100, and the emitted photoelectron is inputted into the electron multiplier 200. At the electron multiplier 200, electrons are emitted for the inputted electrons one by one by dynode 210_1 - 210_N from acceleration and the local field carry out multiplication and corresponding to the light incidence position of the photoelectric surface 100 of last dynode 210_N. By the electric field generated between dynode 210_N and the collector electrode 400, the electron emitted from the electron multiplier 200 is accelerated first, and after passing the collector electrode 400, It slows down by the electric field generated between the collector electrode 400 and each pixel electrode, and enters into one or more pixel electrodes of dynode 210_N and each pixel electrode which were accelerated by voltage and responded to the light incidence position of the photoelectric surface 100 of the signal output part 300 eventually. The pixel electrode which entered the electron outputs the photodetection signal (pixel signals) corresponding to the difference of the number of discharge secondary electrons, and the number of incident electrons while emitting a secondary electron. The electron emitted from the pixel electrode is led to the electric field generated between a pixel electrode and the collector electrode 400, and enters into the collector electrode 400 collectively. The collector electrode 400 outputs the photodetection signal (collector signal) according to the electron number which entered.

[0024]Pixel signals are collected via capacitor C_1 - C_M, and the light incidence position to the photoelectric surface 100 can be measured processing and by analyzing. The total intensity of incident light can usually be obtained from a collector signal. A collector signal can be used also as a trigger signal of measurement.

[0025]

[Effect of the Invention]As mentioned above, according to the detecting position type photo-multiplier of this invention, as explained in detail. Each dynode which constitutes the electron multiplier which carries out multiplication of the electron presupposes that it is common to the incidence position in a photoelectric surface, Since two or more pixel electrodes which can impress potential independently were installed while having a

secondary electron release function arranged at the preceding paragraph of the collector electrode in an acceleration course according to a light incidence position, The heterogeneity of the multiplication factor which the photodetection signal outputted according to the incidence position of light by adjusting the impression potential for every pixel electrode of this produces by the place of an electron multiplier. While being able to abbreviated-equalize (for example, the dependency of the wave height), etc. so much to the incidence position of light, the detecting position type photo-multiplier in which the light incidence detecting position excellent in position resolution is possible is realizable.

[Translation done.]